Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

Institute for Meteorology and Climate Research
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Early Flood Warning for Alpine Catchments through Coupled Precipitation / River Runoff Forecasts

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1st MAP D-PHASE Scientific Meeting, Vienna

Motivation

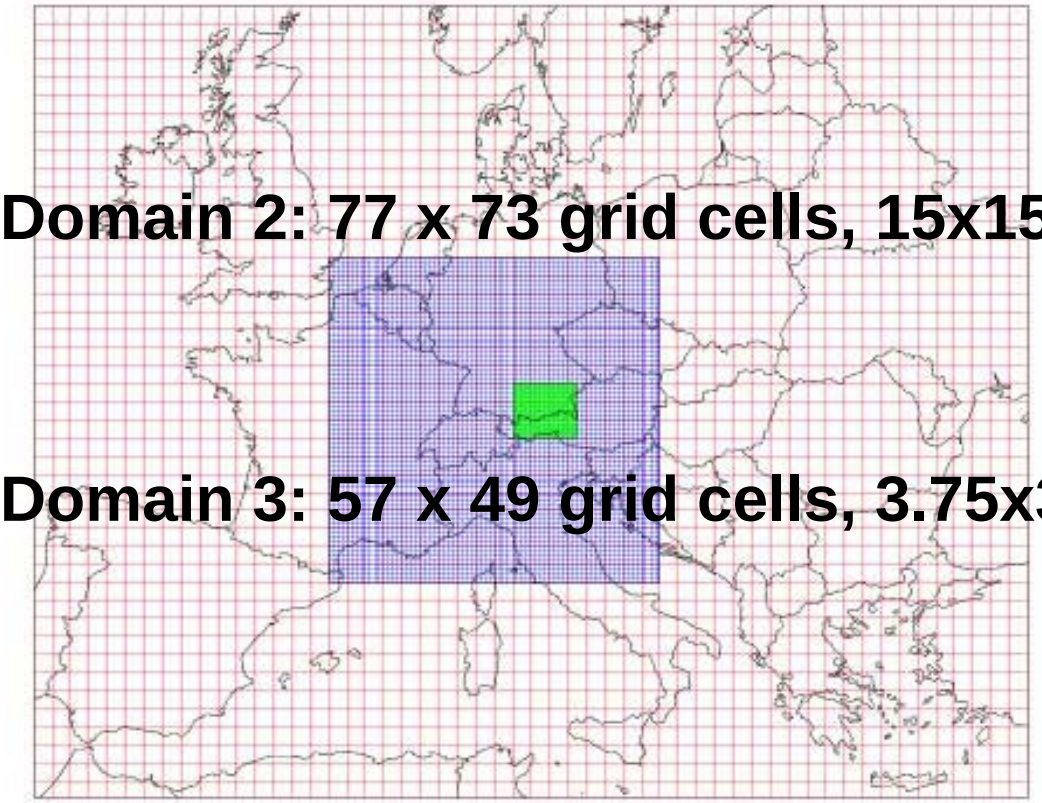
Flood Event	*Total (Mio. €)*	*Insured (Mio. €)*
Bavaria 1999	393	30
Bavaria 2005	205	46
Total 1999	409	40
Total 2005	3000	1700

Numerical Weather Prediction

- NWP (MM5) since 1999 (Christophorus flood) at IMK-IFU
- 72h-Forecast twice daily
- GFS input data
- 26 sigma levels
- 4 Domains, Δx 60 – 1.25 km^2
- Operationally running for 3 Domains, results are published
  http://imk-ifu.fzk.de

Operational NWP at IMK-IFU (MM5) since 1999

Domain 1: 55 x 45 grid cells, 60x60 km²

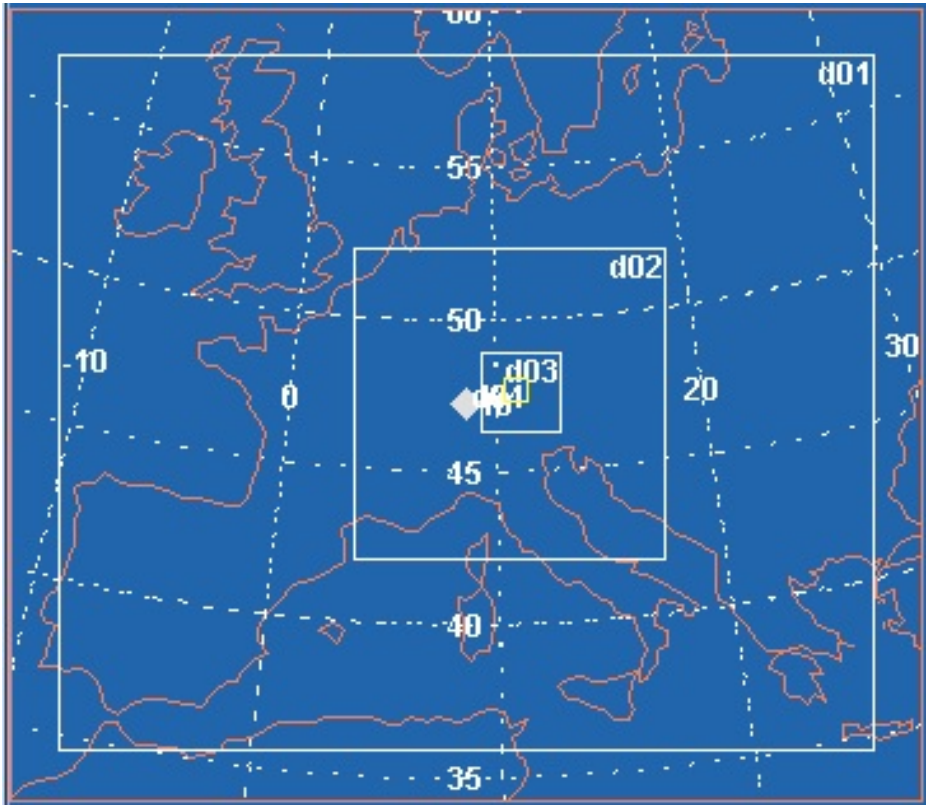


Domain 2: 77 x 73 grid cells, 15x15 km²

Domain 3: 57 x 49 grid cells, 3.75x3.75 km²

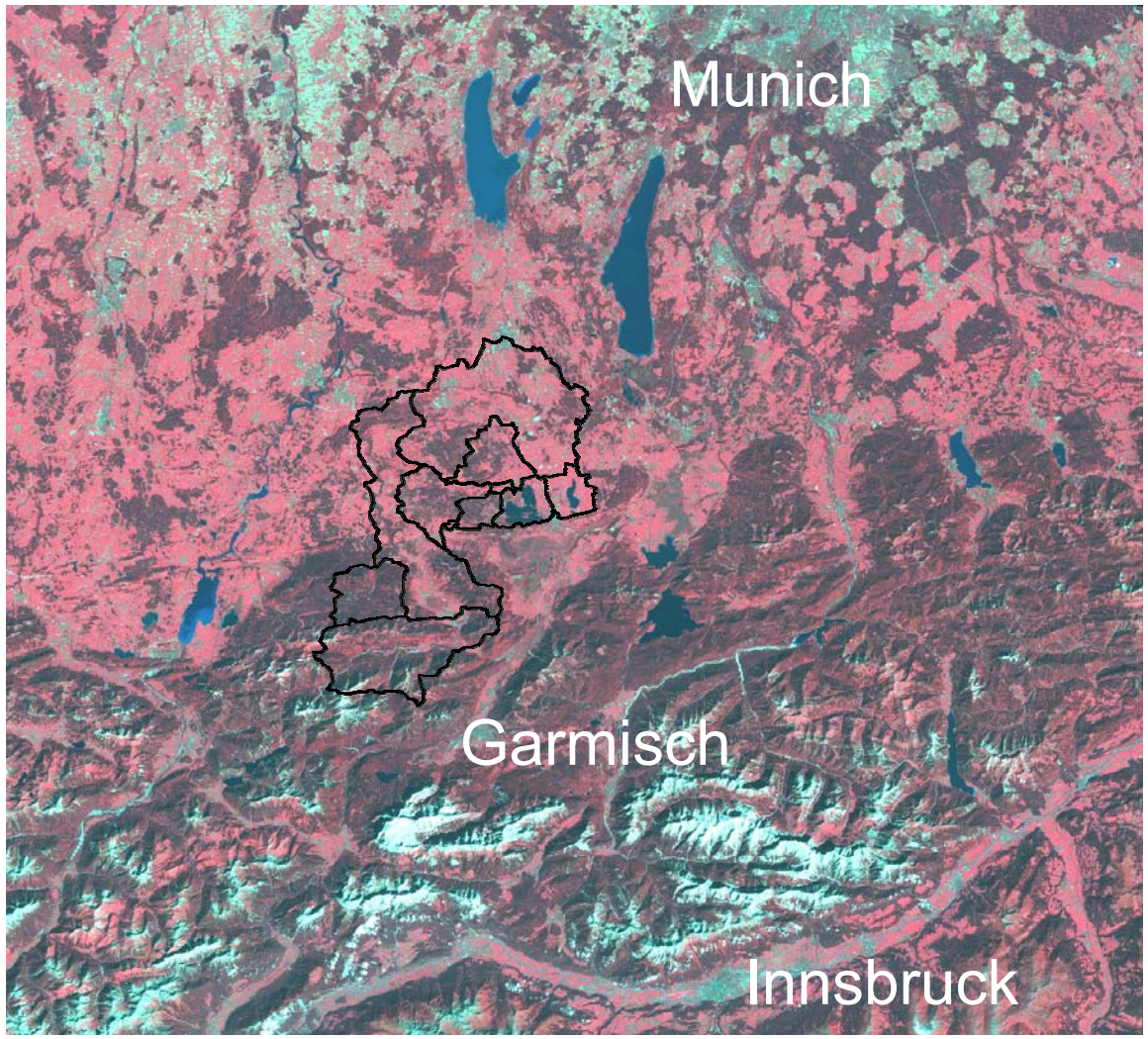
NWP: Weather Research and Forecast (WRF)

- Setup: D1 54×54 km² - D4 2×2 km²
- 33 Sigma-Levels



How good is NWP-precipitation data for flood modelling?

Hydrological testbed Ammer catchment

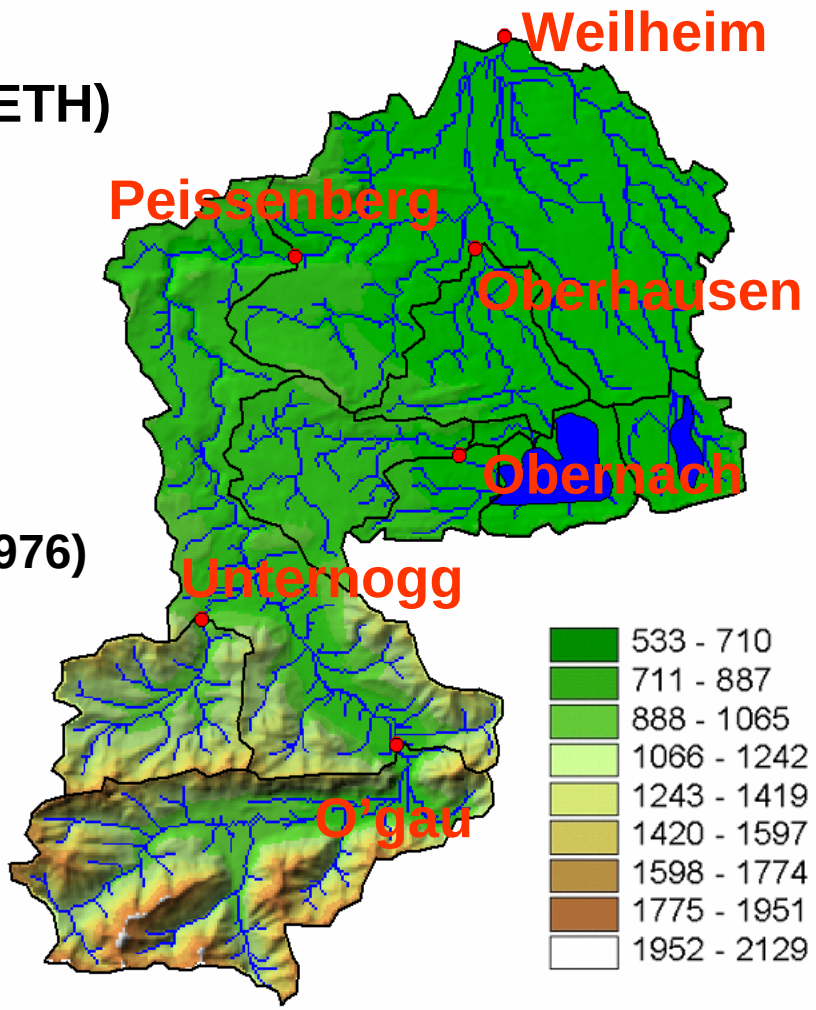


Landsat TM (30m)
[ch 7-5-3]
1991-30-08

Hydrological Modeling

Water Balance Simulation (WaSiM-ETH)
(Schulla & Jasper 2001)

- **distributed Modell, 100 m raster resolution**
- **physically based process descriptions**
- **Richards equation (Richards, 1931)**
- **hydraulic conductivity after van Genuchten (1976)**
- **Evapotranspiration after Penman-Monteith (Monteith, 1975; Brutsaert, 1982)**
- **Snow storage model (Anderson, 1993)**
- **Soil moisture storage**



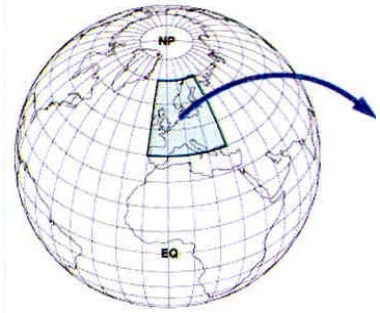
Hydrometeorological Flood Forecast

One-way coupled model system meteorology-hydrology
for alpine catchments:

very short reaction times precipitation-river runoff

Flood Forecast Quality limited due to:
Quality NWP
Challenge alpine Mountains/Valleys:
small errors in space $\Rightarrow$ huge errors in river runoff
Quality hydrological modelling
Processes in alpine environment,
Snow storage & soil moisture content

Flood Forecasting System

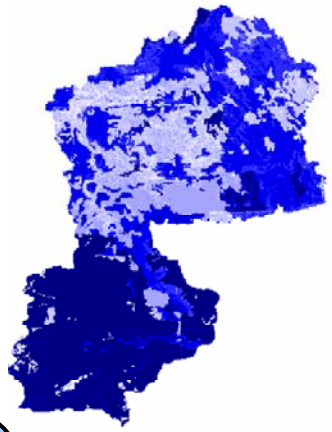


Global Forecasting System

NCEP GFS (AVN)

Observed Met-data

WaSiM-run to provide **initial conditions**

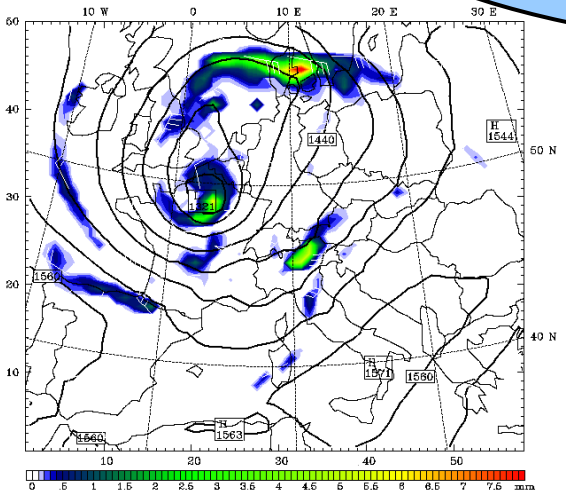


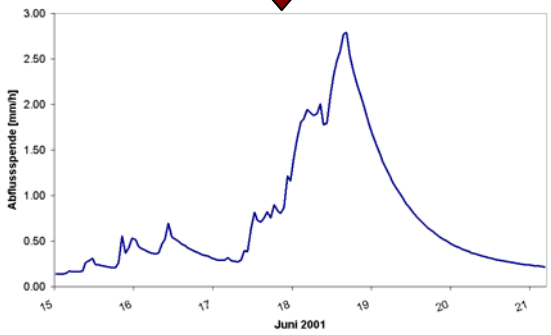
Limited Area Model

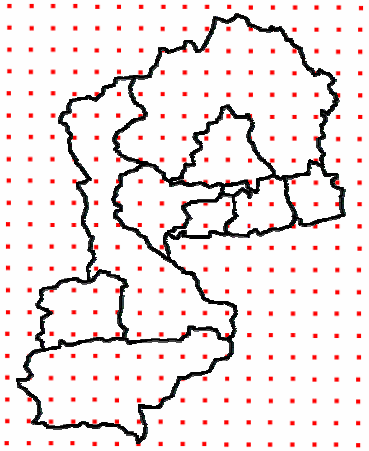
MM5/WRF/MCCM

Water Balance Modell

WaSiM

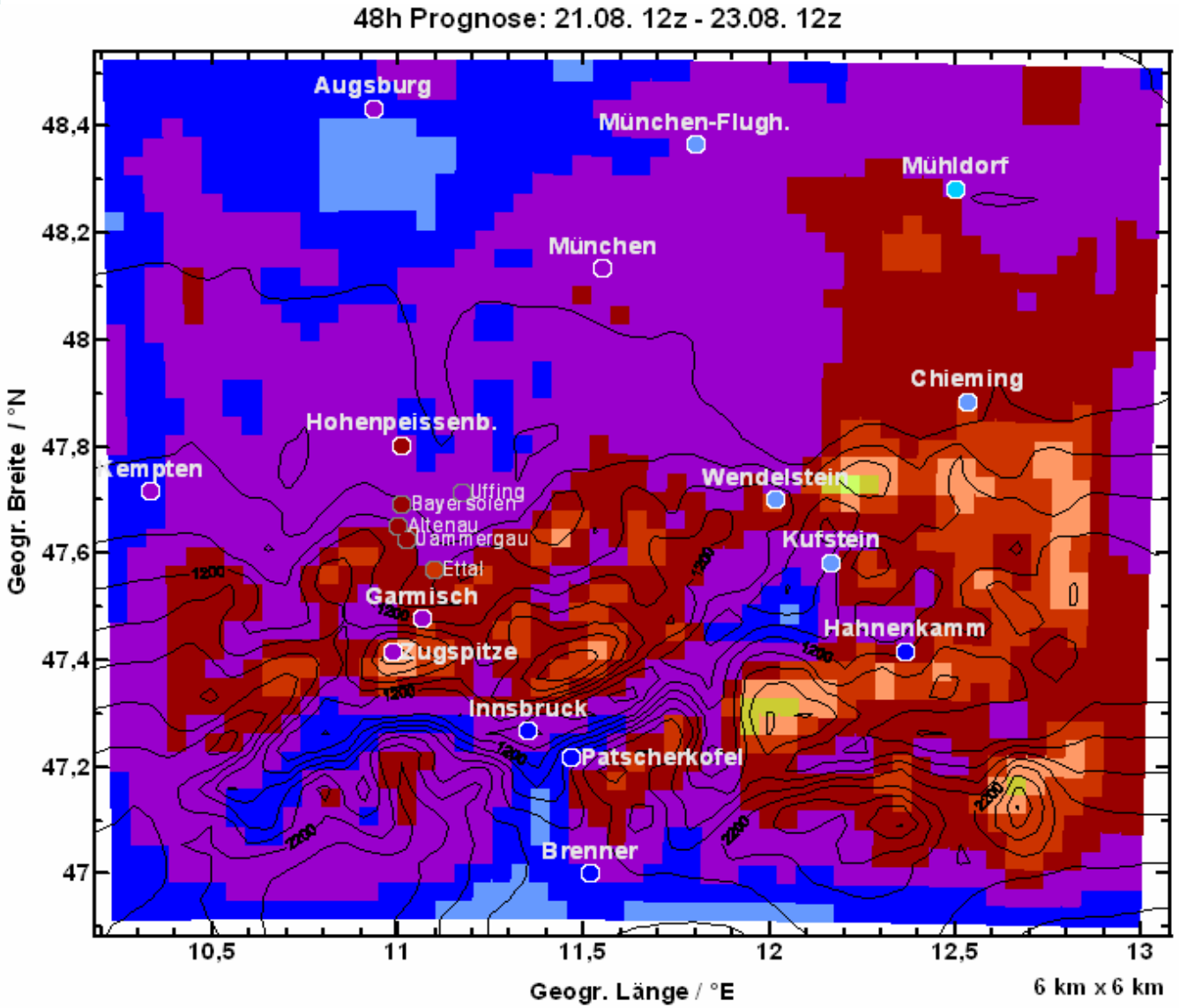






FLOOD FORECAST

Precipitation Forecast August 2005



WRF D03 -Forecast and Comparison to rain gages,

[mm/48h]

- 0.5 - 2 mm
- 2 - 10 mm
- 10 - 20 mm
- 20 - 40 mm
- 40 - 80 mm
- 80 - 120 mm
- 120 - 160 mm
- 160 - 200 mm
- 200 - 240 mm
- 240 - 300 mm

Sensitivity studies WRF-WaSiM Flood Event 2005

- **GFS Forecast- and Analysis-data**
- **Parametrizations**:

a) grid-scale precipitation

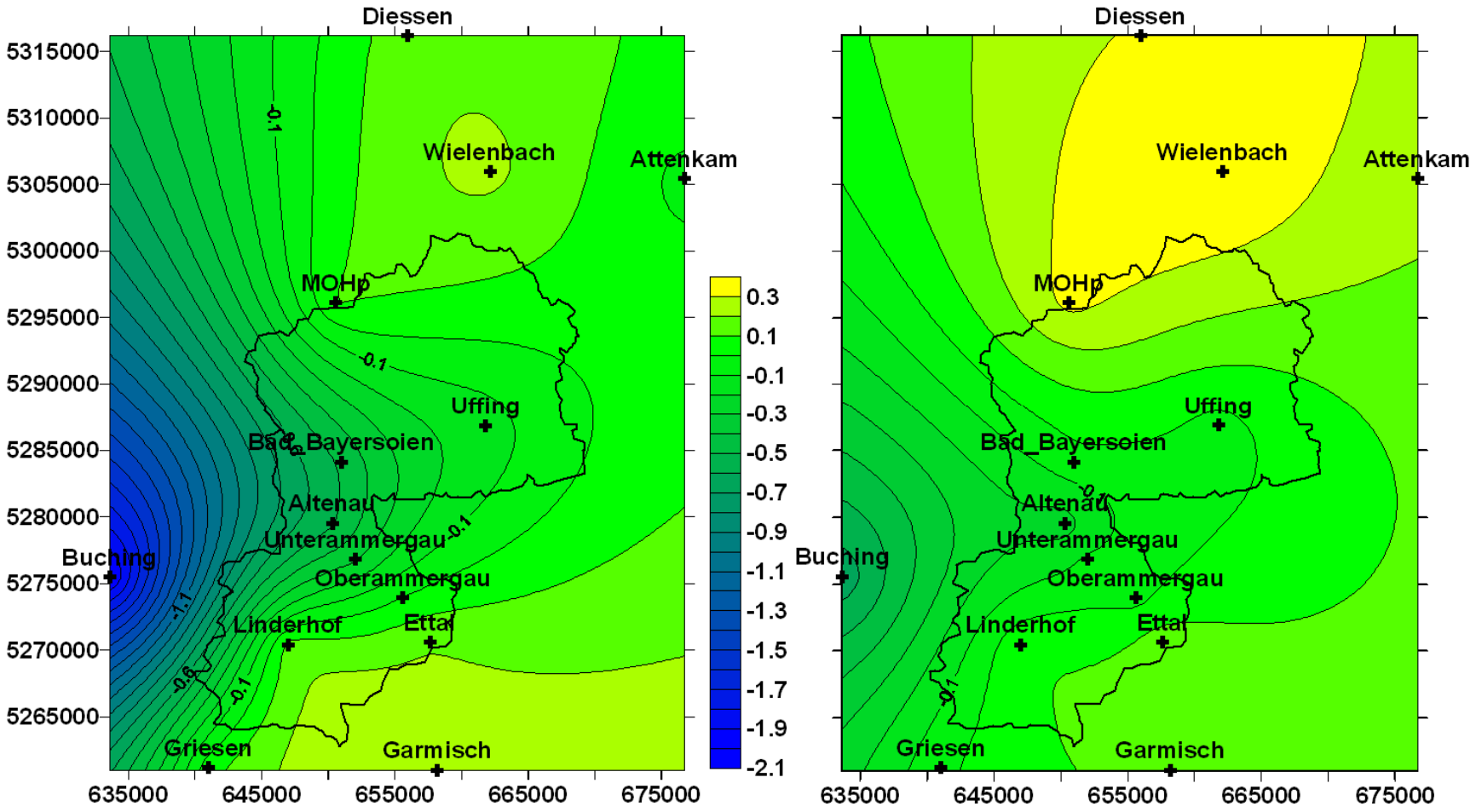
b) cumulus precipitation

c) PBL Options

d) 2 LSM

- 3 options to generate **DEM**
- NWP data from **4 Domains**

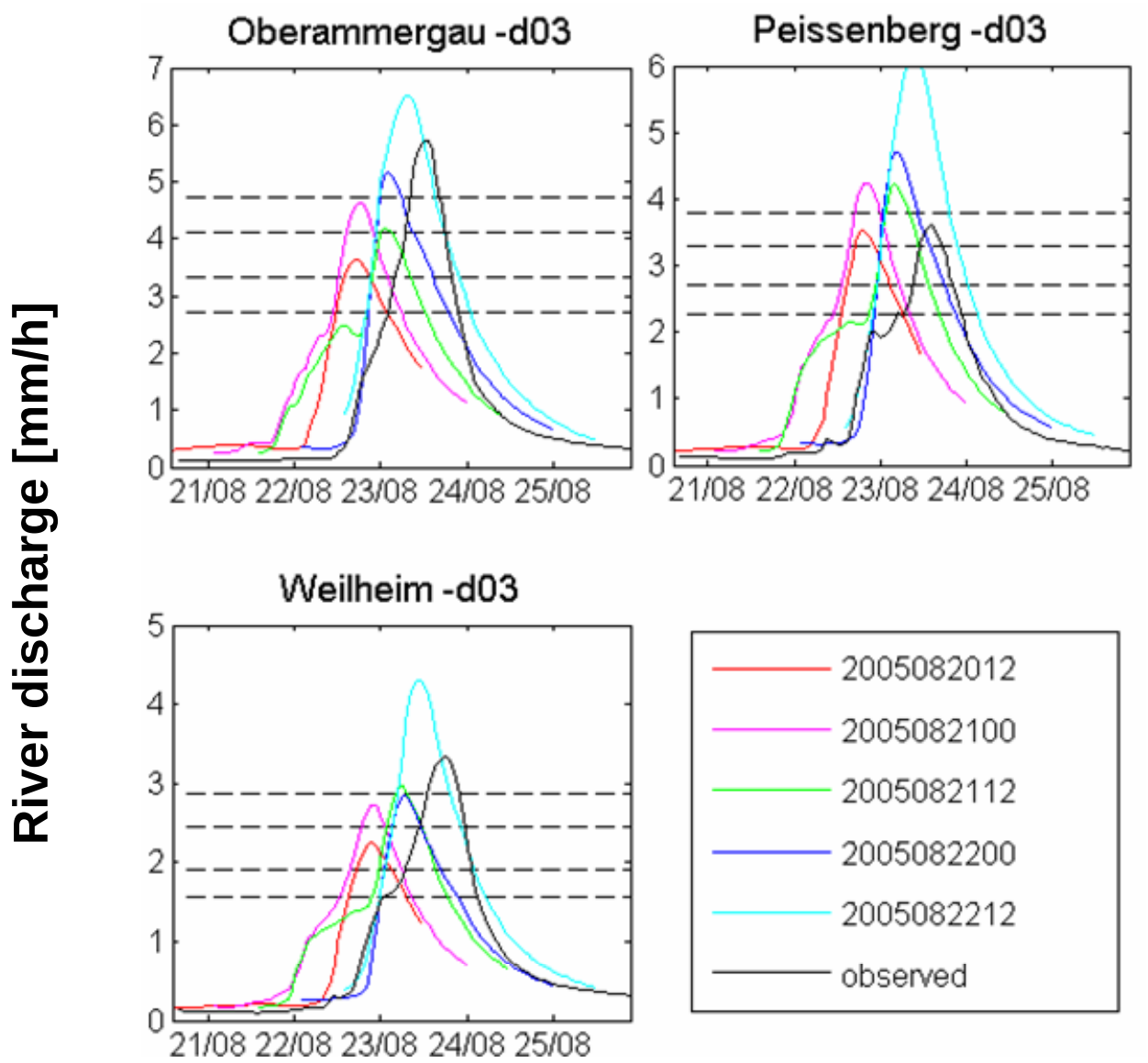
Relative error WRF@6km-rain gage



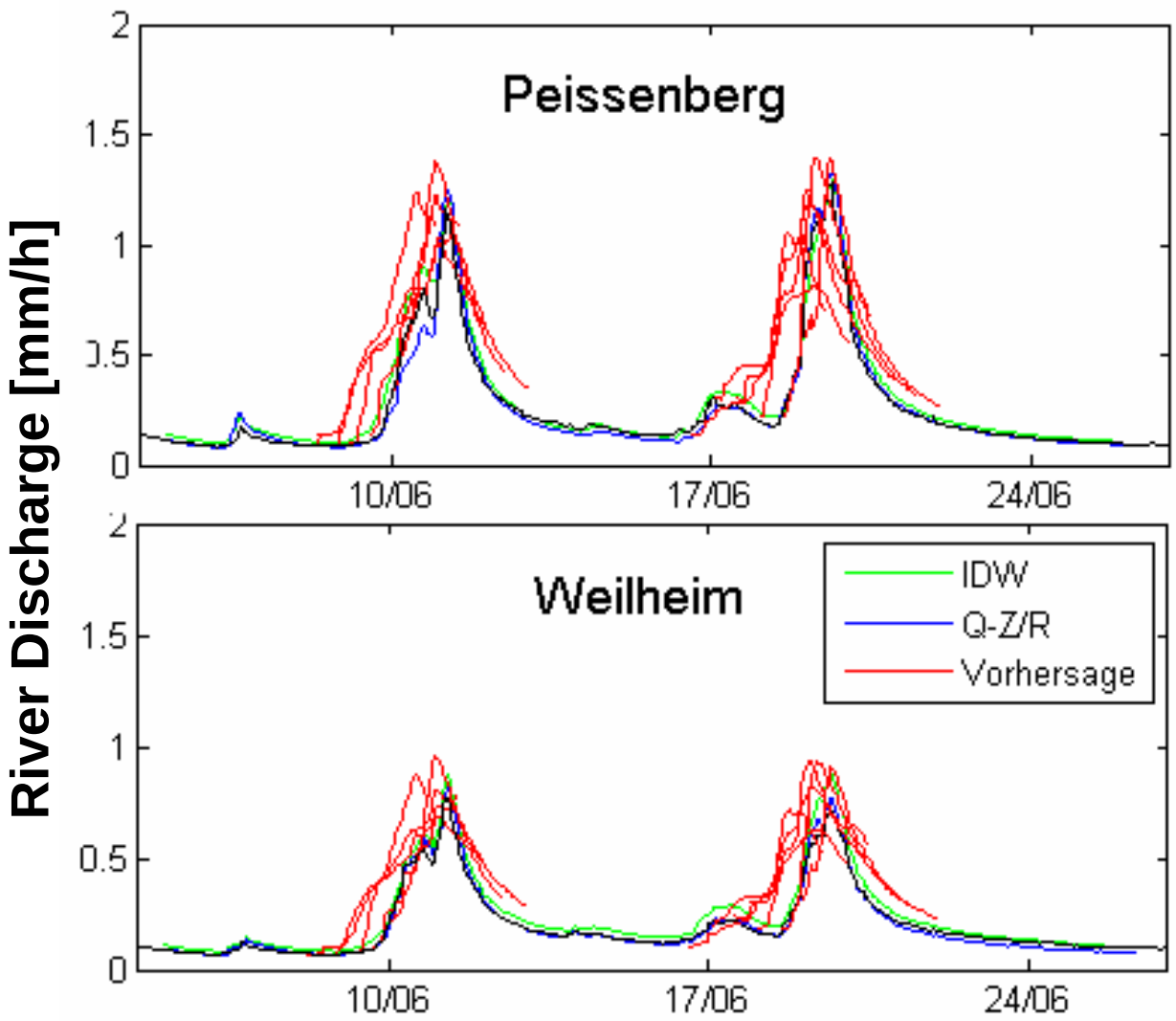
High resolution forecast setup at NCEP Eta parameterization schemes

Cumulus and grid-scale Prec, LSM, PBL

Century Flood August 2005: Five Init Times



Validation period June 2001



red line: forecast

black: observation

green: rain gages

blue: radar rainfall

13 flood forecasts for two runoff events in June 2001

Summary and Outlook

- It is possible to simulate extreme precipitation and river runoff events

- 48h warning results are promising for the Ammer catchment
  but we are not able to give the exact
  - value of maximum discharge
  - point of time of maximum discharge

- Operationalization of forecast system WRF-WaSiM and MM5-WaSiM

- Use of hydrological model PREVAH to

- Extend area for flood forecasting

- We could provide MM5, WRF and WaSiM forecasts to MAP D-PHASE

Thank you.

http://imk-ifu.fzk.de